NCAR/RAF
(Research Aviation Facility)

NetCDF aircraft data standards and compliance with CF conventions

Janine Goldstein & Chris Webster

NCAR Earth Observing Laboratory
Boulder, CO

eighth GO-ESSP community workshop

October 6-8, 2009

ZMAW

Hamburg, Germany

NCAR-RAF netCDF Conventions

➢ Since 1992 RAF has employed netCDF as the primary archival format for aircraft data.

➢ This standard is registered with Unidata as "NCAR-RAF Conventions for Aircraft Data"

➢ It predates the netCDF Climate and Forecast (CF) Metadata Convention

➢ It is largely CF compliant but diverges in a couple key areas.

The standard is online at: http://www.eol.ucar.edu/raf/Software/netCDF.html

Changes to bring RAF conventions into compliance with CF 1.4

Trivial: - add, modify, confirm attributes

➢ Require flag_meaning and flag_value be used together

➢ if variable has Z dim, then add attribute :positive = up/down

➢ Global :coordinates order of dimensions does not follow CF standard

Nontrivial:

➢ Cell boundaries

➢ Time averaging

➢ Sub-second time coordinate

Cell Boundaries

- ## RAF data files include particle data binned by particle size

  float A1DC_LWO(Time, sps1, Vector64) ;
      A1DC_LWO:FirstBin = 1 ;
      A1DC_LWO:LastBin = 63 ;
      A1DC_LWO:CellSizes = 12.5f, 37.5f, 62.5f, 87.5f, 112.5f,
  137.5f, 162.5f, 187.5f, 212.5f, 237.5f, 262.5f, 287.5f, 312.5f, 337.5f,
  362.5f, 387.5f, 412.5f, 437.5f, 462.5f, 487.5f, 512.5f, 537.5f, 562.5f,
  587.5f, 612.5f, 637.5f, 662.5f, 687.5f, 712.5f, 737.5f, 762.5f, 787.5f ;
      A1DC_LWO:CellSizeUnits = "micrometers" ;

- ## CF 4 provides a "bounds" attribute

  float A1DC_LWO(Time, sps1, Vector64);
      A1DC_LWO:bounds = "A1DC_LWO_bnds";
  float A1DC_LWO_bnds(Vector64,nv); //matrix of cell boundaries

Time Averaging

- RAF time-stamp represents the mid-point of the second (i.e. all data for a given second is averaged), not the beginning, which is what is implied.

- Would require extensive NIMBUS code modification for the timestamp to represent the beginning of the second.

- CF 1.4 Solution:
    COMR_AL:cell_methods = "Time: mean";

Sub-Second Time Coordinate

- Currently have a sub-second time coordinate separate from time-stamp:
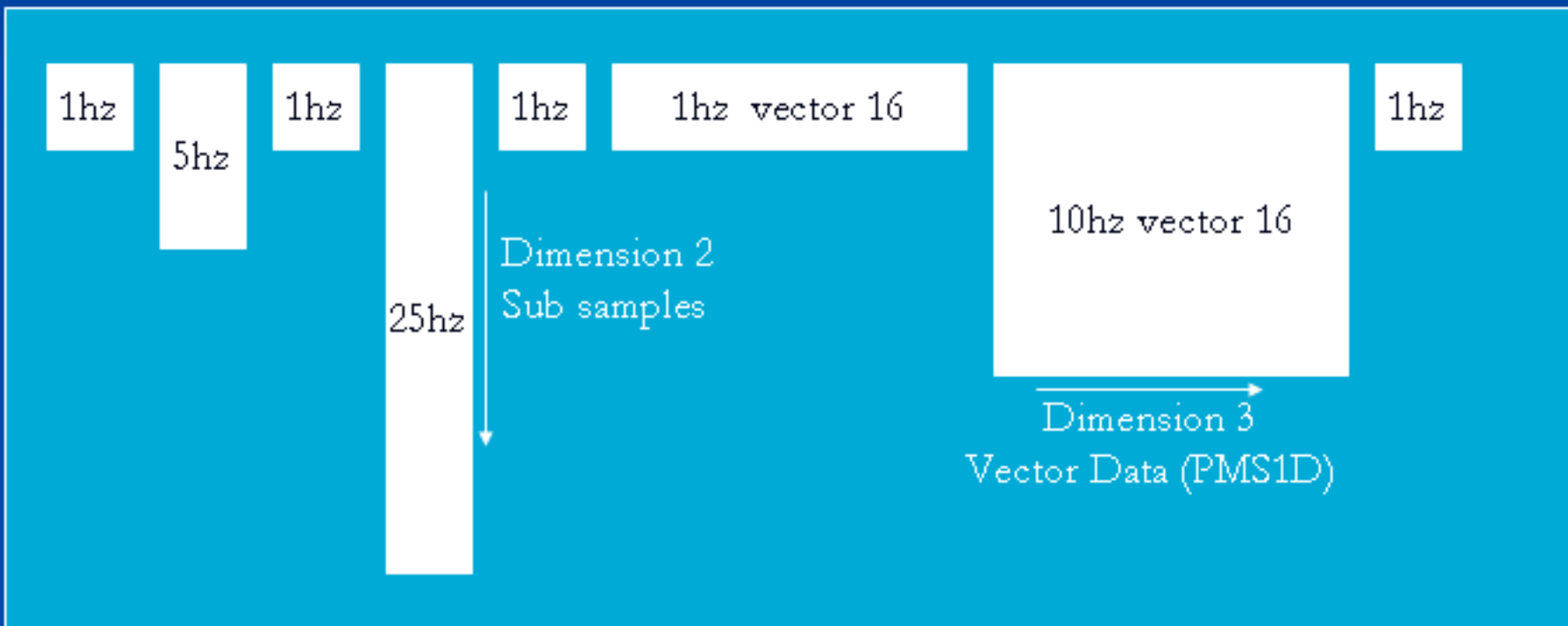
  float COMR_AL(Time, sps25) ;

  This allows multiple data frequencies in the same file without null-filling low rate data.

- For an unlimited time coordinate, this is not CF compliant, and we have received requests to remove it.

Sub-Second Time Coordinate

A single second of data has the following architecture

Hurdles to removing sps dimension

- Maintaining backward compatibility for use with archival datasets.
  - Could be handled via existing :version attribute.

- Upgrading multiple downstream software packages, eg. ncplot, ncpp.
  - Will require funding/manpower

- Removing the sub-second dimension from the RAF netCDF standard would cause lots of padding with _FillValue in data files leading to inordinately large files.

Possible ways to remove sub-second dimension

Under netCDF-3 (RAF currently uses netCDF 3)

- use type double for the Time coordinate

```
variables:
  double time(time) ;
    time:long_name = "time" ;
    time:units = "second since 1970-01-01 00:00:00" ;
data:
  Time = 0,0.04,0.08,... ;
```

But the space taken for the 1hz data would be 25 times larger than it needs to be.

- Include both a 1hz and a 25hz time coordinate in the same file
  - must be regular fixed size dimensions (not unlimited).

```
dimensions:
    time1Hz = 1000;      time25Hz = 25000;
variables:
    float time1Hz (time1Hz ) ;
    float time25Hz (time25Hz ) ;
data:
    float data1(time1Hz ) ;
    float data2(time25Hz ) ;
```

- If want unlimited dimensions then use separate files for 1hz and 25hz data.

- compression by gathering along unlimited dimension
    - CF conventions Section 8.2, "Compression by Gathering"
    - it appears no current software recognizes this convention
    - considered too complex by some users

Under netCDF-4

- groups?

- Is it possible to have multiple unlimited dimensions?

What hurdles will netCDF 4 enhanced model introduce?

  - Not yet widely adopted.
  - Any software to read data in groups or data of the new types must be written to handle the enhanced model.

Standard Expansion

- https://cf-pcmdi.llnl.gov/trac/wiki/PointObservationConventions contains proposed trajectory data standards.

  - There is an opportunity here to influence that standard

References

➢http://www.eol.ucar.edu/raf/Software/netCDF.html

➢http://www.eol.ucar.edu/data/software/downloadcenter

➢http://www.eol.ucar.edu/about/our-organization/cds/ssg/cds-software-

inventory/raf_software-inventory/?searchterm=nimbus

➢http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.4/cf-conventions.html

➢https://cf-pcmdi.llnl.gov/trac/wiki/PointObservationConventions

➢http://www.unidata.ucar.edu/software/netcdf/workshops/2009/cf/index.html

➢http://www.eol.ucar.edu/raf/Headers/Header.506

➢http://www.eol.ucar.edu/raf/Headers/header.506

Thank You!

Questions?

Comments?

janine@ucar.edu

cjw@ucar.edu